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following table is copied from his last paper (*Bulletin of the State University*, Lexington, Kentucky, April, 1908) to illustrate the rather remarkable difference in the time of the appearance of the centers of ossification in the male and female hand:

TIME OF APPEARANCE OF CENTERS OF OSSIFICATION IN THE BONES
OF THE CARPUS

1. Os Magnum (capitatum)	{	<i>Female</i> : between the third and sixth month. <i>Male</i> : between the fourth and tenth month.
2. Unciform (hamatum)	{	<i>Female</i> : between the fifth and tenth month. <i>Male</i> : between the sixth and twelfth month.
3. Cuneiform (triquetrum)	{	<i>Female</i> : between the second and third year. <i>Male</i> : when about three years of age.
4. Semilunar (lunatum)	{	<i>Female</i> : between the third and fourth year. <i>Male</i> : when about four years of age.
5. Scaphoid (navicular)	{	<i>Female</i> : at four years of age, or early in fifth year. <i>Male</i> : when about five years of age.
6. Trapezoid (multangulum majus)	{	<i>Female</i> : between the fourth and fifth year (preceding trapezium). <i>Male</i> : between fifth and sixth year (preceding trapezium).
7. Trapezium (multangulum minus)	{	<i>Female</i> : between fourth and fifth year (preceded by trapezoid). <i>Male</i> : between fifth and sixth year (preceded by trapezoid).
8. Pisiform	{	<i>Female</i> : between the ninth and tenth year. <i>Male</i> : between the twelfth and thirteenth year.

C. R. B.

PLANT CYTOLOGY

Cytological Studies on *Saprolegnia* and *Vaucheria*.—These interesting and important types have been the subject of several investigations dealing with the processes of oogenesis, fertilization, etc., with conclusions at variance in a number of fundamental points. Two papers have recently appeared which should receive careful attention.

Claussen¹ reports upon oogenesis and fertilization of *Saprolegnia monoica*, contributing important evidence on points under dispute through the investigations of Trow and Davis, and pre-

¹ Claussen, P. Ueber Eientwicklung und Befruchtung bei *Saprolegnia monoica*. *Ber. d. Deut. Bot. Gesell.*, XXVI, p. 144, 1908.

senting a very different account and interpretation of the process of oogenesis.

There is a stage in oogenesis, before the eggs are developed, when the protoplasm forms a peripheral layer enclosing a large region free from protoplasm in the interior of the oogonium. Other authors have believed this region to be a space containing cell sap, and developed by the gathering and flowing together of vacuoles in the center of the oogonium. Claussen describes the accumulation within the oogonium of a slimy substance which he believes to be derived from the degeneration of the cytoplasm. This cytoplasmic degeneration is conceived as proceeding outward until finally the protoplasm lies as a relatively thin layer in the form of a hollow sphere under the oogonium wall. The well-known nuclear degeneration accompanies, according to Claussen, that of the cytoplasm until relatively few nuclei remain in the peripheral layer. This account of an extensive cytoplasmic degeneration to form a region filled with slime in a living active cell is not paralleled, so far as the reviewer is aware, in any cytological studies upon plants, and is likely to require more detailed study of a microchemical character before it will be accepted.

Claussen is convinced in agreement with Davis that there is only one mitosis in the oogonium and not two mitoses with chromosome reduction as reported by Trow. This is an important point, since Trow's view of chromosome reduction during oogenesis is contrary to the rule among plants that the processes of gametogenesis are unaccompanied by chromosome reduction. The species of the Saprolegniales which are sexual probably reduce the chromosome number (doubled by the fertilization of the egg) with the germination of the oospore; the apogamous species never have the double number, since the eggs develop parthenogenetically.

The account of nuclear structure, the mitosis, and their significance for the processes of oogenesis presents a point of view entirely different from both Davis and Trow. Claussen reports a central body in the resting nucleus and at each pole of the intranuclear spindle. He believes that these establish a nuclear structure with polar organization similar to that of *Phyllactinia* as described by Harper (see review in the July number of the *NATURALIST*), but on account of the small size of the nucleus the behavior of this central body was not studied in detail. Each

daughter nucleus following the mitosis is accompanied by such a central body, or centrosome, with delicate protoplasmic radiations; the greater number of these daughter nuclei degenerate. The cytoplasm begins to gather around those which survive, and such regions become the egg origins. Each egg origin has then in its interior a nucleus accompanied by a central body with radiations that extend outward in all directions through the cytoplasm. There is finally a cleavage of the cytoplasm between the egg origins and a rounding up of the protoplasm of each to form the egg.

The central body of Claussen with its radiations is very conspicuous at certain stages of oogenesis. Davis believed the structure to be analogous to the coenocentrum of the Peronosporales and to be developed in the cytoplasm without genetic relation to the nucleus. Trow described asters associated with the surviving nuclei of the oogonium and believed them to be accompanied by deeply staining material constituting a body called by him an ovocentrum. The coenocentrum of Davis corresponds to the ovocentrum and egg aster of Trow and to the central body with radiations of Claussen. The views of Claussen are very interesting and the theory is logical, but his observations on the central body are not sufficiently detailed to establish fully his conclusions. The nuclei of the Saprolegniales and Peronosporales have been studied by a number of competent observers who have failed to find a polar organization. However, these nuclei are small and the problem difficult, and further investigation may establish nuclear polarity in these groups of fungi similar to that in the Ascomycetes as determined by Harper. Should such evidence be forthcoming, the subject of nuclear structure and behavior in the Phycomycetes will take on an entirely new aspect of great significance in the explanation of the processes of gametogenesis and fertilization.

Claussen finds that the eggs of *Saprolegnia monoica* are fertilized, thus adding another form to Trow's list of sexual species, and it seems clear that fertilization occurs for a number of species in this group of fungi which is so largely apogamous. There is a single mitosis in the antheridium, with radiations around the central bodies less evident than in the oogonium. The antheridial tubes on entering the oogonium may apply themselves directly to the egg, but more frequently the ends branch and their tips become applied to several eggs. Finally

the end of such a tip opens and a sperm nucleus enters the egg, passing quickly to the female nucleus, which lies in the center and is without an evident central body. The sperm nucleus increases in size until the two fusing gamete nuclei become indistinguishable. The mitoses of oospore germination were not observed. Claussen found no bi- and tri-nucleate eggs in *Saprolegnia monoica* as were reported by Davis for an apandrous form of *Saprolegnia mixta*.

Studies on several species of *Vaucheria* by Heidinger² are reported in a lengthy paper by Heidinger on the development of their sexual organs. The investigation was conducted in the laboratory of Oltmanns and centers around the disputed point as to how the mature oogonium with its one egg comes to contain a single nucleus, when the young oogonium is multinucleate. Oltmanns described the migration or withdrawal into the main filament of all of the numerous nuclei present in the young oogonium with the exception of one, which remained to become the nucleus of the egg. Davis holds that the young oogonium is multinucleate even after the formation of the cross wall, separating it from the parent filament, and that there is a process of nuclear degeneration during which all break down with the exception of a single surviving nucleus that comes to lie in the center of the egg.

Heidinger's conclusions are in agreement with the views of Oltmanns. All of the numerous nuclei except the future egg nucleus are said to leave the developing oogonium and to pass back into the parent filament before the appearance of the cross wall which separates the oogonium from the parent filament. Heidinger finds no process of nuclear degeneration as described by Davis. The egg nucleus, which remains after the process of nuclear migration, lies at first at the tip of the oogonium and is accompanied by a centrosome-like body, with protoplasmic radiations, similar to the central body described by Claussen for the eggs of *Saprolegnia*; shortly before fertilization this nucleus passes to the center of the egg.

The paper gives many details of the series of events during the period of fructification and describes interesting culture methods. The cytological account is, however, open to criticism. The fixation was in $\frac{1}{2}$ -1 per cent. chrom-acetic acid, a very

² Heidinger, W. Die Entwicklung der Sexualorgane bei *Vaucheria*. *Ber. d. Deut. Bot. Gesell.*, XXVI, p. 313, 1908.

strong fluid for such delicate algæ, and there was evidently much shrinkage of the material, as shown in the outlines of the text figures. These latter are not satisfactory, considering the importance of the details which are discussed, and in the opinion of the reviewer are not convincing. There are some fundamental principles concerned in the discussion between Oltmanns and Davis which will require more thorough investigation before final conclusions are likely to be reached. The most important of these concern the history of the developing oogonium after the multinucleate stage, and the factors that lead to the selection of the nucleus which comes to preside over the egg.

BRADLEY M. DAVIS.

HOLOTHURIANS

Holothurioidea.¹—Under the above title Östergren has made a noteworthy contribution to the literature concerning the Holothurioidea. Based upon years of special study of the group, he concludes that in order to estimate the value of an organ in taxonomy and phylogeny, the function of the organ must be completely understood.

Ostergren first discusses respiration, particularly in connection with the enteron as respiratory organ. By means of their dilator muscles, sometimes the œsophagus, but most often the cloaca, functions as a pump to force the water into other parts of the enteron, or into especially developed extensions of the same. The primitive condition is found in the Synaptidæ.

In most of the Elaspoda respiratory trees are lacking, and yet the cloaca is provided with dilators, and doubtless functions as a pump to force water into the enteron. As Ludwig (1889-92) points out, in various members of the Elpidiidae and Psychropotidae, a simple unpaired evagination appears as a "rudimentary gill," or water-lung. From such a beginning comes the single, or double, stemmed respiratory trees. Since it is possible to have within a natural genus certain species without water-lungs, others with them rudimentary, and still others with well-developed respiratory trees, Östergren maintains that the presence, or absence, of these organs is of no particular importance in taxonomy.

¹ Östergren, Hjalmar. Zur Phylogenie und Systematik der Seewalzen. Särtryck ur Zoologiska Studier tillägnade Professor T. Tullberg. Upsala. October 12, 1907.